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OIPE JC139 DEC 1 2 2003 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT OFFICE

Serial No.: 09/824,779

Filed: April 4, 2001

Inventors: Paul M. Reepschlager

Title: Automatic Fiber-Type Identification Technique

Docket No: 3650-010US

AFFIDAVIT UNDER 37 C.F.R. 1.131

I, Paul M. Reepschlager of Ottawa, Ontario, Canada hereby make oath and say as follows:

(1) THAT the attached "Invention Disclosure Submission Reply" and "FiberIDpatent.doc" mentioned therein and attached hereto were produced before the filing date (February 26, 2001) of United States Patent Application No. 09/791,685 (which has no domestic priority) which has been published under Publication No. U.S. 2002/0118442 A1.

(2) THAT the subject matter of the instant application (United States Patent Application No. 09/824,779 was conceived before the filing date (February 26, 2001) of published United States Patent Application No. 09/791,685(which has no domestic priority).

EXECUTED at Ottawa, Ontario, Canada

this 10th day of December, 2003.

Paul M. Reepschlager

SWORN BEFORE ME at the City of Ottawa

in the Regional Municipality of Ottawa-Carleton

this 10th day of December, 2003.

Commissioner for Oaths or Notary Public

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Invention Disclosure Submission Reply

Disc No:		Received Date:	
Disclosure Title:	Automatic Fiber-Type Identification Technique		

---=== Inventors ===---

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Global Id	Name	Work Info	Home Info
0173768	**HR Name:** REEPSCHLAGER, PAUL M **Known As:** PAUL **Email:** reeper@americasm01.nt.com **Mgr First Name:** MARC **Mgr Last Name:** VEILLEUX **Mgr Global ID:** 1687109	**Location:** 1285 BASELINE ROAD **Location Code:** SKY **Dept:** 1U21 **Phone:** 3950623 **Ext Phone:** **Fax:** 613-763-4215 **Ext Fax:** 613-763-4215 **MailStop:** 04579B06 **Citizenship:** CANADA	**Address:** 62 TARTAN DRIVE NEPEAN, ON CANADA K2J2V5 **Phone:** (613)8237544

---=== Attachments ===---

File Name	File Type	File Comments
FiberIDpatent.doc	Microsoft Word (*.doc)	

<End of Attachments>

Were there additional inventors involved?	no	Was there contractor involvement?	no
Name of Supervisor or Divisional Head:		Name of VP:	
MARC VEILLEUX			
[illegible] LOB:	SP&C	[illegible] Business Unit:	Other (SP&C)
Conception Date:			
Has this invention been discussed with others? If yes, please complete			
Inside Nortel - Whom?		Outside Nortel - Whom?	
Inside Nortel - When?		Outside Nortel - When?	
NDA?	yes		
Are you aware of any imminent future disclosures? Please provide dates and details			
No.			
Keywords for Searching:		Products that will use this invention:	

Does this invention arise from any arrangement involving an external organization?	no
Is this invention relevant to a Standards Activity?	Internal Funding Project #
no	251-25994

Technical Information

Brief Description of the Invention

The algorithm specifies a method for automatically identifying a fiber type in an optically amplified span. The procedure consists of two stages:1) Collect a span loss profile for the fiber type in question, and2) Apply a defined analysis strategy on the profile information to identify the fiber type.

Problem Solved by the Invention

A customer may specify that a certain fiber type is used within a span, and may provide outdated or false information based on link upgrades. In particular, if a large segment of foreign type fiber has been spliced into a span, it is important to identify that this has occurred.

Solutions that have been tried and why they didn't work?

Based only on customer information for fiber type, provisionning occurs. It may only be discovered in field during system deployment if the fiber type is wrong or is spliced in-span with another fiber type. There is no method for making type identifications, and no tool for making an estimate of a foreign fiber type spliced into a link.

Specific elements or steps that solved the problem and how they do it

The fiber loss profile is mapped, and statistics on the normalized profile are made. Theses statistics fit into an equation to deliver a score for the measurement. Scores for different fiber types have been pre-measured. The identification scores have been suitably spaced to permit a fit of the measured fiber score against the fiber type identifiers.

Commercial value of the invention to Nortel and Nortel's major competitors:

Advantage over competitor for identifying a fiber type in a network actively, and identifying if a possible hybrid splice exists. This also premits an auto mapping of networks.

Automatic Fiber-Type Identification

Paul Reepschlager

Department 1U21

Background

As channel capacity over a fiber multiplies, it becomes increasingly important to have specific knowledge the fiber's loss profile and to be able to positively identify the fiber type. This information is of particular importance in a span implementing a Raman Pump amplification technique.

The Invention

The algorithm below specifies a method for automatically identifying a fiber type in an optically amplified span. The procedure consists of two stages:

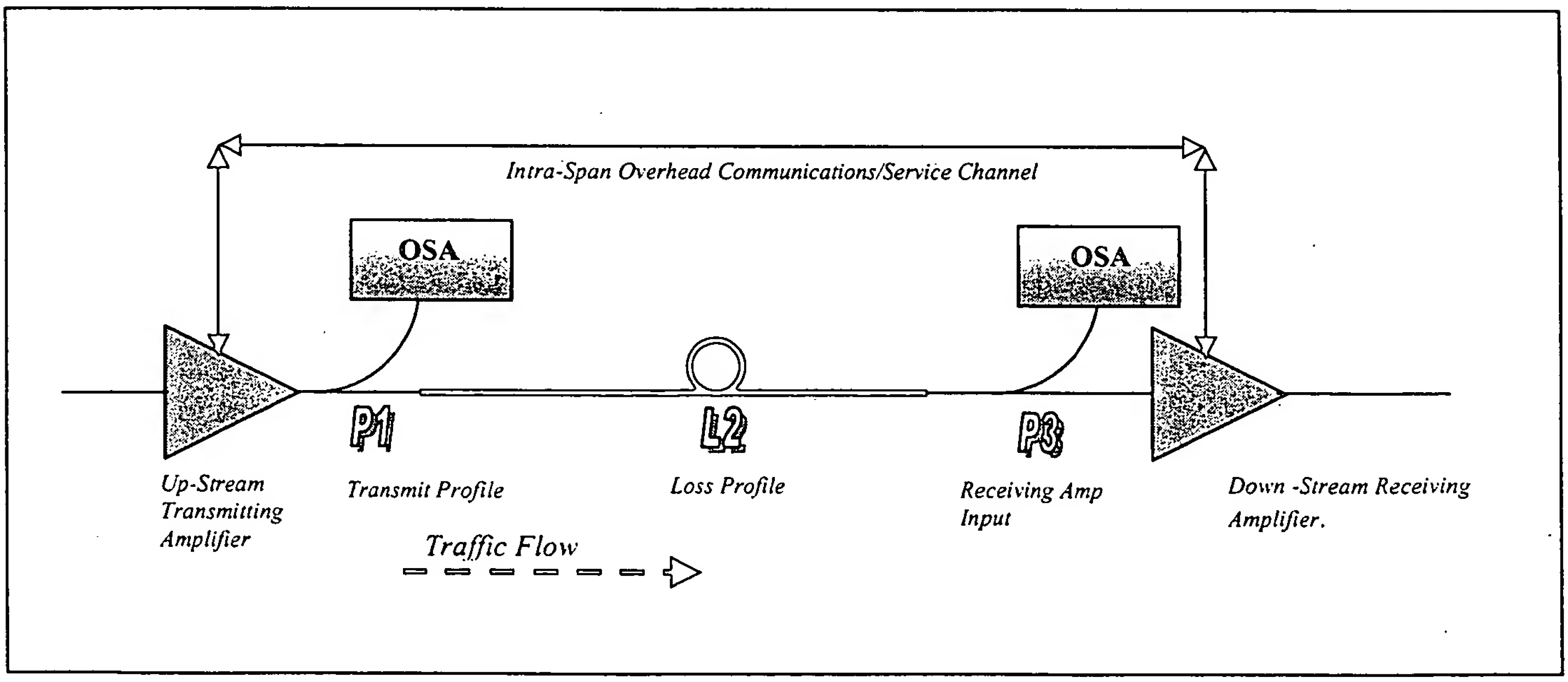
1) Collect a span loss profile for the fiber type in question, and
2) Apply a defined analysis strategy on the profile information to identify the fiber type.

Loss Profile Derivation

In-system span loss measurements are generally limited to the gathering of mean power measurements at both the transmit amplifier output and at the receiving amplifier input, with subtraction to arrive at a mean loss. In certain applications, such as Raman amplification, mean span loss measurements are insufficient. A complete mapping of the fiber loss profile may be required.

The inclusion of cost effective optical spectrum analyzers (OSA) to monitor wavelength profiles has permitted the mapping of transmit and receive wavelength profiles within a span. If collected in a central location (say at the receiver) this mapping information can be utilized to derive the span loss profile.

Determining Span Loss Using System Parameters



In the above diagram, $P1(\lambda)$ represents the profile of the transmitting amplifier, $P3(\lambda)$ represents the receiving amplifier profile, and $L2(\lambda)$ represents the loss profile.

Measurement of the loss profile can be effected under system start-up conditions. If the transmit amplifier pumps are turned up to deliver superfluous (high power) ASE, this launched ASE profile could first be measured at the transmit amplifier output using an OSA, $P1(\lambda)$, and then measured at the receiving amplifier input, $P3(\lambda)$. The difference between the profiles would provide a mapping of the span loss profile, $L2(\lambda)$.

Fiber Type Auto-Detect

The per-span mapping of the fiber loss profile leads to a fiber-type identification application. Consider the following algorithm.

1) Measure the fiber loss profile according to the loss profile mapping technique described above .
2) Focus only at the loss profile measurements across a pre-defined window of wavelengths.
3) Scale the loss profile with respect to the first blue wavelength measured value (or some other pre-defined value).
4) Find statistics on this normalized distribution, such as:
   - the integral of all distribution values, Σ,
   - the mean of the distribution, μ,
   - the standard deviation of the distribution, σ,
   - the minimum value of the distribution. min,
   - the maximum value of the distribution, Max,
   - and the value measured at ONE identifying wavelength, $\lambda 1$
5) Sum the statistical values above, weighted by appropriate pre-defined coefficients A1 to A6:

$$Score = A1 \cdot \Sigma + A2 \cdot \mu + A3 \cdot \sigma + A4 \cdot \min + A5 \cdot Max + A6 \cdot \lambda 1$$

6) Steps 1 to 4 will have previously been conducted for all fiber types supported by a product line using *typical* loss profile measurements. An analysis of the numbers gathered in 4) for each fiber type must be performed to define the coefficients A1 to A6. It is desired to choose these coefficients such that a sufficient spread will exist between the indicator scores for each fiber type. The fiber identification scores will have been tabulated in a look up table.
7) The measured score will be compared against the tabulated indicators to determine the fiber type by method of "closest score".

The reason for using statistical numbers on the distributions lies in the true inability to define the existence a "typical" profile for the fiber type. Statistics on the profiles, however, will provide better fingerprints, with room for within-type fiber-to-fiber random

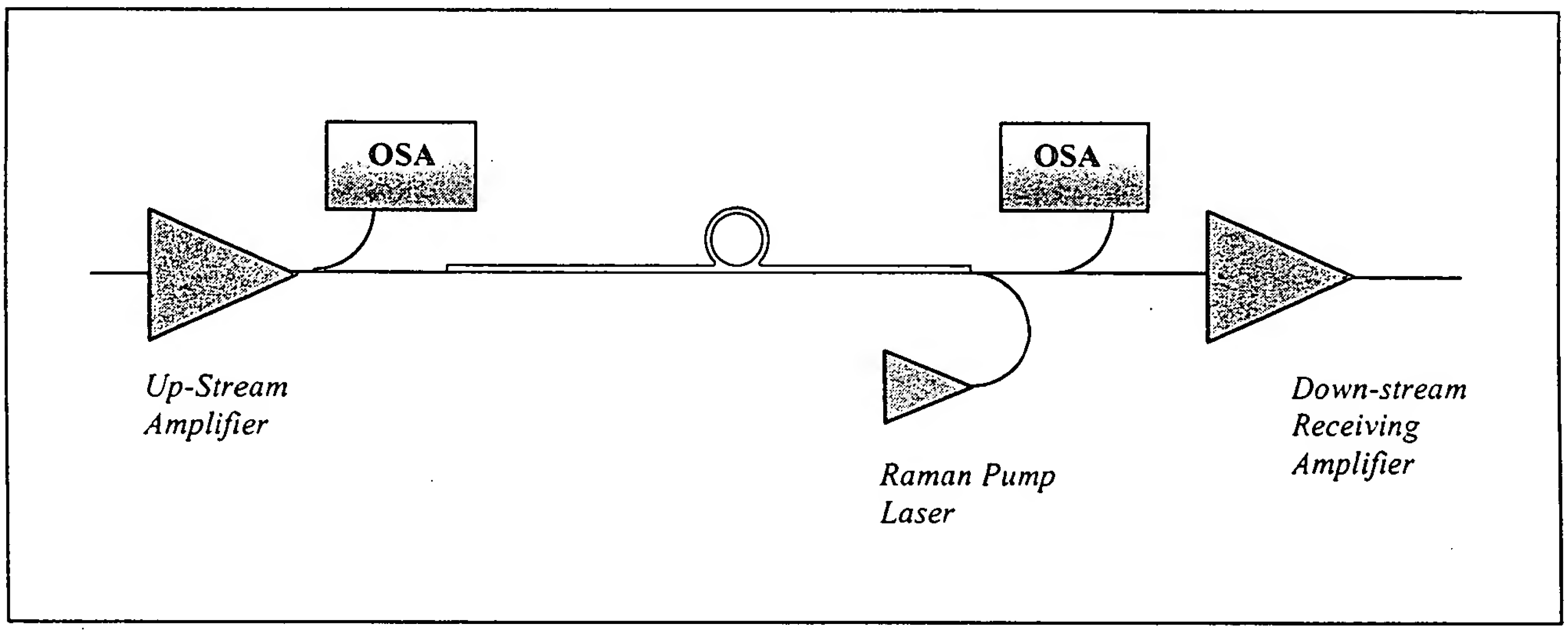
differences on discrete wavelength measurements. The uniqueness of these statistics between fiber types will dictate the weighting coefficient values, such that the sum of the products (coefficient * statistic) will give a unique score per fiber type.

Furthering the Identification Technique Using Raman Gain Profiles

The identification analysis can be further extended using a similar technique against measured and known Raman gain profiles.

While ASE is being sent by the transmitting amplifier, both P1(λ) and P3(λ) have been measured. A Raman pump laser can be applied onto the system, and the in-band resultant Raman gain will be noted as a change in P3(λ). The change in P3 before and after the application of the Raman pump will provide the Raman gain profile.

Fiber Type Identification Using Raman Gain Profile Measurements



A pre-defined window of wavelengths can be statistically interpreted in the same manner as used above for the span loss profile. Once again, typical profiles for all supported fiber types will have been previously gathered. Statistics on these fiber types will be scrutinized and weighting coefficients assigned to the statistical indicators to provide identification scores. These scores would be used to identify the fiber type on an in-field measured span.

The inability to match measured against typical results for both the loss profile fiber identification method AND for the Raman profile fiber identification method may indicate the existence of a mixed fiber-type within a span.